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(54) **Antibacterial and antifungal silicone rubber compositions.**

(57) A silicone rubber composition mainly comprising an organopolysiloxane of the average compositional formula:  $R^1SiO_{(4-n)/2}$  wherein  $R^1$  is a substituted or unsubstituted monovalent hydrocarbon group and  $n = 1.98$  to  $2.02$  can be rendered antibacterial and antifungal by blending a zeolite containing 0.1 to 15% by weight of a silver ion.

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This invention relates to antibacterial and/or antifungal silicone rubber compositions, and to ways of imparting antibacterial and antifungal properties to silicone rubber products e.g. to improve the living environment, prolong lifetime and improve food hygiene.

## 5 Prior Art

In the recent years, silicone rubber is used in a wide variety of applications covering electronic, automotive, building, medical and food industries because of its excellent properties including weatherability, electrical properties, low compression set, heat resistance, and low-temperature resistance. Typical uses include pack-  
10 ings or gaskets in refrigerators, electric rice cookers, and electric pots as exemplary home appliances, pack-  
ings in food-keeping containers, and medical tubes like catheters. The demand for silicone rubber is increasing and there is a need for developing a silicone rubber having more versatile properties.

It was recently proposed to add antifungal agents to render silicone rubber antifungal. Most antifungal  
15 agents used heretofore are organic agents such as benzimidazole, and methylsulfonyl. Since these organic  
agents are susceptible to a temperature change, light like ultraviolet radiation, a humidity change, or trace components in the environment and can be deteriorated thereby, their effect does not last long.

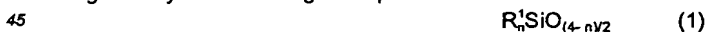
Attempts have been made for sustaining the antifungal effect by coating or capsulating such organic an-  
tifungal agents or by adding active substances to the silicone polymer. These attempts, however, suffer from  
several problems, for example, (1) an increased cost, (2) failure to exert effect because organic antifungal  
20 agents can be buried in silicone rubber, (3) difficulty of storage because products treated with antifungal  
agents gradually deteriorate in effect even if they are not in use, and (4) degradation by heat vulcanization,  
which degrades organic antifungal agents with drastic reduction in their effectiveness and discolouration of  
silicone rubber moldings.

More recently, inorganic antifungal and antibacterial agents were developed. For example, Japanese Pa-  
25 tent Application Kokai (JP-A) No. 1226/1993 discloses water-soluble glass containing a silver ion, zinc ion, cop-  
per ion or a mixture thereof. JP-A 20559/1990 discloses blending of protein silver. JP-A 93360/1992 discloses  
blending of ZnO, MgO, propionates or a mixture thereof. These proposals, however, suffer from several prob-  
lems. For example, it is difficult to carry sufficient ions. Some agents cause silicone rubber to be discolored.  
Some agents lose ion-carrying ability (and hence their effect) under high-temperature treatment. Some agents  
30 must be added in large amounts in order to maintain antifungal activity. Some agents are prohibited from the  
standpoint of food hygiene.

The general aim herein is to provide new and useful antibacterial and antifungal silicone rubber compo-  
sitions and ways of making them. The preferred particular aim is to exert antibacterial and antifungal activities  
over a long time while maintaining the properties inherent to silicone rubber.

We have found that by blending a silicone rubber composition with a zeolite containing 0.1 to 15% by weight  
35 of a silver ion, we could obtain a silicone rubber in which the silver ion-containing zeolite is dispersed. The  
silicone rubber having the silver ion-containing zeolite dispersed therein had significant antibacterial and an-  
tifungal activities, which were resistant against temperature change by vulcanization of the silicone rubber  
composition, humidity change after vulcanization molding, and environmental change e.g. by exposure to ul-  
traviolet radiation. Dispersion of the zeolite did not adversely affect the inherent properties of silicone rubber.  
40 The present proposals are predicated on this finding.

In one aspect herein, there is provided an antibacterial, antifungal silicone rubber composition comprising  
an organopolysiloxane and a zeolite containing 0.1 to 15% by weight of a silver ion. The organopolysiloxane  
is generally of the average compositional formula:



wherein R<sup>1</sup> which may be identical or different is a substituted or unsubstituted monovalent hydrocarbon group  
and n is a positive number of 1.98 to 2.02.

Aspects are set out in the claims.

## 50 DETAILED DESCRIPTION

A first essential component of the silicone rubber composition is an organopolysiloxane, usually of average  
compositional formula (1).



Groups R<sup>1</sup> may be identical or different monovalent hydrocarbon groups, preferably having 1 to 10 carbon  
atoms, more preferably 1 to 8 carbon atoms, and are selected from alkyl groups such as methyl, ethyl, propyl  
and butyl; cycloalkyl groups such as cyclohexyl; alkenyl groups such as vinyl, allyl, butenyl, and hexenyl, and

aryl groups such as phenyl and tolyl. They may be substituted, in which case some or all of the hydrogen atoms attached to carbon atoms of these groups are replaced by substituents not damaging to the composition and its desired effects. These are well-known, and the skilled person may use routine knowledge in selecting them e.g. halogen atoms, cyano groups or the like. Chloromethyl, trifluoropropyl and cyanoethyl are typical. Groups R<sup>1</sup> preferably include 0.001 to 5 mol%, more preferably 0.01 to 0.5 mol% of alkenyl group. Letter n is a positive number of 1.98 to 2.02. The organopolysiloxanes are preferably blocked at their molecular chain end with a trimethylsilyl, dimethylvinyl, dimethylhydroxysilyl, trivinylsilyl or similar group. They are preferably of straight chain although a mixture of two or more organopolysiloxanes of different molecular structure is acceptable.

Preferably the organopolysiloxanes have an average degree of polymerization of about 100 to 30,000, more preferably about 3,000 to 10,000 and a viscosity of at least about 100 centistokes at 25°C, more preferably about 100,000 to 10,000,000 centistokes at 25°C.

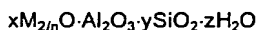
These organopolysiloxanes are generally reparable by co-hydrolysis condensation of one or more selected organohalogenosilanes or by ring-opening polymerization of cyclic polysiloxanes (siloxane trimer or tetramer) in the presence of alkaline or acidic catalysts.

If desired, reinforcing silica powder may be blended in the silicone rubber composition.

The reinforcing silica powder is essential for producing silicone rubber having mechanical strength and to this end desirably has a specific surface area of at least 50 m<sup>2</sup>/g, especially 100 to 300 m<sup>2</sup>/g. Silica powder having a specific surface area of less than 50 m<sup>2</sup>/g would result in cured products with lower mechanical strength. Examples of the reinforcing silica powder include fumed silica and precipitated silica. Surface treated (hydrophobic) silicas are preferable. Preferably the reinforcing silica powder is added in amounts of about 5 to 70 parts, especially about 30 to 50 parts by weight to 100 parts by weight of the first component or organopolysiloxane. Less than 5 parts of silica on this basis would be less effective for reinforcement whereas a silicone rubber composition containing more than 70 parts of silica on this basis would be difficult to work with and the resulting silicone rubber would be rather low in mechanical strength.

In such a silicone rubber composition, a zeolite containing 0.1 to 15% by weight of a silver ion is blended for the purpose of imparting antibacterial and antifungal properties thereto.

The zeolite used herein may be either natural or artificial zeolite. The zeolite is generally aluminosilicate having a three-dimensional skeleton structure and represented by the following general formula, as well-known:



M is an ion capable of ion exchange, typically a monovalent or divalent metal ion, n is a valence of the (metal) ion, x and y are coefficients of the metal oxide and silica, and z is a number of crystallization water. Examples of the zeolite include A-type zeolite, X-type zeolite, Y-type zeolite, T-type zeolite, high silica zeolite, sodalite, mordenite, analcime, clinobutyronite, chabazite, and erionite though not limited thereto. These exemplary zeolites have an ion-exchange capacity of 7 meq/g for A-type zeolite, 6.4 meq/g for X-type zeolite, 5 meq/g for Y-type zeolite, 3.4 meq/g for T-type zeolite, 11.5 meq/g for sodalite, 2.8 meq/g for mordenite, 5 meq/g for analcime, 2.6 meq/g for clinobutyronite, 5 meq/g for chabazite, and 3.8 meq/g for erionite. They all have a sufficient capacity to ion-exchange with ammonium and silver ions.

The antibacterial zeolite used herein is a zeolite in which an ion-exchangeable ion, for example, a sodium, calcium, potassium, magnesium, and iron ion is partially or entirely replaced by a silver ion. In addition to the silver ion, it may contain another antibacterial metal ion, for example, ions of copper, zinc, mercury, lead, tin, bismuth, cadmium, chromium and thallium, with the copper and zinc ions being preferred. It is desired that zeolite be exchanged by an ammonium ion in addition to the silver ion.

From the standpoint of antibacterial activity, the silver ion should be contained in the zeolite in an amount of 0.1 to 15% by weight. A silver ion concentration of less than 0.1% is insufficient to provide antibacterial activity whereas more than 15% tends to cause discoloration. These percentages are percents by weight based on the dry weight of zeolite at 110°C. Preferably the zeolite containing 0.2 to 5% by weight of a silver ion. Zeolite containing 0.2 to 5% by weight of a silver ion and 0.1 to 16% by weight of a copper or zinc ion is preferred for antibacterial activity. Ammonium ion can be contained in zeolite in amounts of up to 20% by weight although the content of ammonium ion in zeolite should preferably be 0.5 to 5% by weight, especially 0.5 to 2% by weight for preventing discoloration of zeolite.

Preferably the antibacterial zeolite is blended in the silicone rubber composition in an amount of about 0.05 to 50 parts, especially 0.5 to 10 parts by weight per 100 parts by weight of the first component or organopolysiloxane. Less than 0.05 parts of the zeolite would be less effective for rendering the composition antibacterial whereas a silicone rubber composition containing more than 50 parts of the zeolite on this basis would be difficult to work with and the resulting silicone rubber would be low in mechanical strength or discolored.

The silicone rubber composition typically includes a curing agent for curing the organopolysiloxane e.g. in a conventional manner.

Any of well-known curing agents may be used and curing can be done in a conventional manner suitable for the selected curing agent. More particularly, where crosslinking reaction takes place between hydrocarbons side-group, suitable curing agents are organic peroxides such as benzoyl peroxide, 2,4-dichlorobenzoyl peroxide, p-methylbenzoyl peroxide, 2,4-dicumyl peroxide, 2,5-dimethyl-bis(2,5-t-butylperoxy)hexane, di-t-butyl peroxide, and t-butyl perbenzoate. The organic peroxide is preferably added in amounts of about 0.1 to 5 parts by weight per 100 parts by weight of the first component or organopolysiloxane.

In an embodiment where the organo-polysiloxane as the first component has an alkenyl group directly attached to a silicon atom, curing may be done by using an organo-hydrogenpolysiloxane having at least two hydrogen atoms each directly attached to a silicon atom in a molecule as the curing agent whereby crosslinking takes place through addition reaction. The organohydrogenpolysiloxane used herein may be straight, branched or cyclic, but preferably has a degree of polymerization of up to 300. Useful examples are a diorganopolysiloxane end-blocked with a dimethylhydrogensilyl group, copolymers consisting of a dimethylsiloxane unit, a methylhydrogensiloxane unit, and a terminal trimethylsiloxy unit, a low viscosity fluid consisting of a dimethylhydrogensiloxane ( $\text{H}(\text{CH}_3)_2\text{SiO}_{1/2}$ ) unit and a  $\text{SiO}_2$  unit, 1,3,5,7-tetrahydrogen-1,3,5,7-tetramethylcyclotetrasiloxane, 1-propyl-3,5,7-trihydrogen-1,3,5,7-tetramethylcyclotetrasiloxane, and 1,5-dihydrogen-3,7-dihexyl-1,3,5,7-tetramethylcyclotetrasiloxane. The organo-hydrogenpolysiloxane as the curing agent is desirably added in such amounts that the hydrogen atom directly attached to a silicon atom is 50 to 500 mol% relative to the alkenyl group of the organopolysiloxane as the first component.

Preferably the addition reaction is assisted by adding any of well-known platinum catalysts. Exemplary catalysts include platinum element alone, platinum compounds, platinum composites, chloroplatinic acid, complexes of chloroplatinic acid with alcohols, aldehydes, ethers and olefins. The platinum catalyst is added in an amount of about 1 to 2,000 ppm of platinum atom based on the organopolysiloxane as the first component.

In addition to the above-mentioned components, the silicone rubber composition may further contain fillers insofar as the benefits of the invention are not lost. Exemplary fillers are extending fillers such as ground quartz and calcium carbonate. Inorganic or organic blowing agents may be added if spongy products are desired. Exemplary blowing agents include azobisisobutyronitrile, dinitropentamethylenetetramine, and benzene-sulfonylhydrazide. The blowing agent is preferably added in an amount of 3 to 10 parts by weight per 100 parts by weight of the silicone rubber compound. When such a blowing agent is added to the composition, spongy silicone rubber is available.

If desired, the composition may further contain various additives such as coloring agents and heat-resistance enhancing agents as well as reaction control agents, mold release agents and filler dispersants. Exemplary filler dispersants are diphenylsilane diol, various alkoxysilanes, carbon functional silanes, and silanol group-containing low molecular weight siloxanes although their addition amount should be minimized so as to avoid any adverse influence.

The silicone rubber composition may be prepared by uniformly mixing the components by means of a rubber kneader such as a two-roll mill, Banbury mixer or dough mixer followed by optional heat treatment. If desired, the composition is prepared by premixing the first component or organopolysiloxane and a second component or reinforcing silica to form a base compound, adding a third component or antibacterial zeolite and optionally a fourth component or curing agent thereto, and mixing them.

The silicone rubber composition can be molded into a desired silicone rubber shape by conventional molding techniques such as casting, compression molding or extrusion molding. The molded product is post cured at 100 to 200°C for 1/2 to 24 hours if desired.

By curing the silicone rubber composition, there is obtainable a silicone rubber having the silver ion-containing zeolite dispersed therein which exerts antibacterial and antifungal activities in a stable manner over a long term and possesses favorable rubber properties. Then the silicone rubber finds applications as packings or gaskets in home appliances such as refrigerators, electric rice cookers, electric pots, and microwave ovens, packings in food-keeping containers, tubes and hoses in automatic beverage vending machines, packings in cosmetic containers and cosmetic puff, and medical tubes.

## EXAMPLE

Examples of the invention are given below by way of illustration and not by way of limitation. All parts are by weight.

### Preparation of antibacterial zeolites

Two commercially available zeolites were used: A-type zeolite ( $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot x\text{H}_2\text{O}$ , mean particle size 4.3  $\mu\text{m}$ ) and Y-type zeolite ( $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 \cdot x\text{H}_2\text{O}$ , mean particle size 0.7  $\mu\text{m}$ ). Four metal salts:  $\text{AgNO}_3$ ,

$\text{Cu}(\text{NO}_3)_2$ ,  $\text{Zn}(\text{NO}_3)_2$ , and  $\text{NH}_4\text{NO}_3$  were used as the salt for providing an ion for ion exchange. Table 1 shows the type of zeolite and the content of metal ions used in preparing antibacterial zeolite Nos. 1 to 5.

Each sample was prepared by weighing 1 kg of zeolite powder which had been dried by heating at 110°C, suspending the zeolite in 1 liter of water, and adding dropwise an aqueous solution of 0.05 N nitric acid at a rate of 100 ml/30 min. until a desired pH value (5 to 7) was reached. To the slurry, 3 liters of an aqueous mix solution containing silver nitrate, copper nitrate, zinc nitrate and ammonium nitrate in predetermined concentrations was added for ion exchange. This reaction was achieved by agitating at a temperature of room temperature to 60°C for 24 hours until an equilibrium state was reached. At the end of ion exchange, the zeolite phase was collected by filtration and washed with room temperature water or warm water until the excess of exchange cation was removed from the zeolite phase. The sample was finally dried by heating at 110°C. Five samples were obtained in this way.

Table 1

Sample No.	Zeolite	Content in zeolite, wt%			
		Ag	Cu	Zn	Ammonium
1	A-type zeolite	0.5	0	15.0	1.0
2	A-type zeolite	5.0	0	12.0	1.0
3	A-type zeolite	14.5	1.0	8.0	1.0
4	Y-type zeolite	0.2	0	12.5	0
5	Y-type zeolite	3.5	7.5	0	0.5

#### Examples 1-5

To 100 parts of an organopolysiloxane consisting of 99.825 mol% of a dimethylsiloxane unit, 0.15 mol% of a methylvinylsiloxane unit, and 0.025 mol% of a dimethylvinylsiloxane unit and having an average degree of polymerization of about 8,000 were added 3 parts of diphenylsilane diol as a dispersant, 4 parts of a silanol group-terminated dimethylpolysiloxane having a degree of polymerization of 10, and 40 parts of fumed silica having a specific surface area of 200 m<sup>2</sup>/g (commercially available from Nippon Aerosil K.K.). The ingredients were mixed and heat treated for 2 hours to obtain a base compound.

To 100 parts of the base compound, 0.5, 5 or 12 parts of each of antibacterial zeolite Nos. 1 to 5 was added in a two-roll mill. Dispersion was accomplished by a three-roll mill. By further adding 0.8 parts of 2,5-dimethylbis(2,5-t-butylperoxy)hexane thereto, a silicone rubber composition was prepared. It was press cured at 165°C for 10 minutes and post cured at 200°C for 4 hours, obtaining an antibacterial silicone rubber sheet.

#### Comparative Example 1

A silicone rubber sheet was obtained by the same procedure as in Example 1 except that no antibacterial zeolite was added to the base compound.

#### Comparative Example 2

A silicone rubber sheet was obtained by the same procedure as in Example 1 except that benzimidazole was added as an organic antifungal agent to the base compound.

The thus obtained silicone rubber sheets were examined for antibacterial and antifungal activities.

#### Antibacterial test

Each sample (50 × 50 mm) was treated with flowing water for one hour. Then 1 ml of a solution containing 10<sup>5</sup> cells/ml of *Staphylococcus aureus* (abbreviated as SA) and 1 ml of a solution containing 10<sup>5</sup> cells/ml of *Escherichia coli* (abbreviated as EC) were placed on the sample and incubated at 37°C for 24 hours. Thereafter, the bacterial cells were washed out with sterilized phosphate buffered solution (PBS). The viable cell count in the wash solution was measured by a pour plate method using cell counting media. The results are shown in

Table 2.

Antifungal test

- 5 Each sample (50 mm in diameter, 2 mm thick) was tested according to JIS Z-2911. A potato dextrose agar medium was used and cultivation done at 28°C for 14 days. The fungi tested were *Aspergillus terreus* (abbreviated as AT), *Penicillium funiculosum* (abbreviated as PF), *Cladosporium cladosporioides* (abbreviated as CC), and *Chaetomium globosum* (abbreviated as CG). The test results were rated in a 0-5 point scale as shown below.

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Point	Growth of fungal cells
0	no fungal growth on sample surface
1	less than 10% of sample surface area
2	10-20% of sample surface area
3	20-30% of sample surface area
4	30-40% of sample surface area
5	more than 40% of sample surface area

The test results are shown in Table 3.

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Table 2  
ANTI-BACTERIAL TEST

	Amount of zeolite (g)	Viable cell count (/ml)		Sheet dis- coloration
		SA	EC	
Example 1	0.5	$1.0 \times 10^1$	$1.0 \times 10^1$	no
	5	0	0	no
	12	0	0	no
Example 2	0.5	0	0	no
	5	0	0	no
	12	0	0	slightly yellowed
Example 3	0.5	0	0	no
	5	0	0	slightly yellowed
	12	0	0	slightly yellowed
Example 4	0.5	$1.0 \times 10^1$	$1.0 \times 10^1$	no
	5	0	0	no
	12	0	0	no
Example 5	0.5	0	0	no
	5	0	0	no
	12	0	0	slightly yellowed
Com - parative Example 1	0	$1.5 \times 10^5$	$3.4 \times 10^5$	no
Com - parative Example 2	0.1*	$8.3 \times 10^4$	$3.4 \times 10^5$	yellowed
	0.5*	$6.3 \times 10^4$	$1.3 \times 10^5$	yellowed
	1.0*	$2.3 \times 10^4$	$3.2 \times 10^4$	yellowed

\* Benzimidazole, not zeolite

Table 3  
ANTI-FUNGAL TEST

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	Amount of zeolite	Points in Antifungal Test			
		AT	PF	CC	CG
Example 1	0.5	2	1	2	1
	5	1	0	2	0
	12	1	0	1	0
Example 2	0.5	1	1	1	0
	5	0	0	1	0
	12	0	0	1	0
Example 3	0.5	1	0	1	0
	5	0	0	1	0
	12	0	0	1	0
Example 4	0.5	2	1	2	1
	5	1	1	2	0
	12	1	1	1	0
Example 5	0.5	1	1	1	0
	5	0	0	1	0
	12	0	0	1	0
Com — parative Example 1	0	4	5	4	5
Com — parative Example 2	0.1 *	5	4	4	4
	0.5 *	4	4	3	4
	1.0 *	4	4	4	5

\* Benzimidazole, not zeolite

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The novel silicone rubber having added thereto 0.5 g of the particular zeolite of Example 1 and the silicone rubbers of Comparative Examples 1 and 2 were subjected to various durability tests. The results are shown in Tables 4 to 6.

#### 55 Heat resistance test

The sheet samples were kept in an oven at 100°C, 200°C, and 250°C for three days before physical properties were measured to determine a change thereof before and after heat treatment.



Hot water immersion test

The sheet samples were immersed in water at 50°C and 80°C for 7 to 14 days and dried in air at room temperature for one day before physical properties were measured.

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Pressure cooker test

The sheet samples were kept in an autoclave filled with steam at 150°C before physical properties were measured.

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Table 4: Heat resistant test

	Properties	Plain sample (Comparative Example 1)	Antibacterial silicone rubber (Example 1)	Antibacterial silicone rubber (Comparative Example 2)
Initial	Outer appearance	milky white translucent	milky white	yellow
	Specific gravity @25°C	1.16	1.17	1.17
	Hardness (JIS - A)	61	61	58
	Tensile strength (kgf/cm <sup>2</sup> )	115	112	101
	Elongation (%)	390	390	468
	Tear strength A (kgf/cm)	16	17	15
	Impact resilience (%)	55	44	40
	Compression set @100°C/22 hr.	7	6	12
100°C × 3 days	Hardness (JIS - A)	60 (+1 point)	61 (±0 point)	58 (±0 point)
	Tensile strength (kgf/cm <sup>2</sup> )	119 (+3%)	104 (-7%)	100 (-1%)
	Elongation (%)	385 (-3%)	370 (-5%)	459 (-2%)
	Hardness (JIS - A)	65 (+4 points)	65 (+4 points)	62 (-4 points)
200°C × 3 days	Tensile strength (kgf/cm <sup>2</sup> )	109 (-5%)	107 (-4%)	98 (-3%)
	Elongation (%)	345 (-12%)	340 (-13%)	410 (-12%)
	Hardness (JIS - A)	78 (+17 points)	72 (+11 points)	73 (+15 points)
	Tensile strength (kgf/cm <sup>2</sup> )	64 (-44%)	75 (-33%)	63 (-37%)
250°C × 3 days	Elongation (%)	75 (-81%)	160 (-59%)	81 (-83%)

Table 5: Hot water immersion test

	Properties	Plain sample (Comparative Example 1)	Antibacterial silicone rubber (Example 1)	Antibacterial silicone rubber (Comparative Example 2)
50 °C × 7 days	Hardness (JIS - A)	63 (+2 points)	62 (+1 point)	59 (+1 point)
	Tensile strength (kgf/cm <sup>2</sup> )	99 (-14%)	93 (-17%)	92 (-9%)
	Elongation (%)	330 (-15%)	345 (-12%)	410 (-12%)
50 °C × 14 days	Hardness (JIS - A)	63 (+2 points)	65 (+4 points)	61 (+3 points)
	Tensile strength (kgf/cm <sup>2</sup> )	101 (-12%)	108 (-4%)	90 (-11%)
	Elongation (%)	345 (-12%)	390 (±0%)	416 (-11%)
80 °C × 7 days	Hardness (JIS - A)	70 (+9 points)	66 (+5 points)	66 (+8 points)
	Tensile strength (kgf/cm <sup>2</sup> )	95 (-17%)	98 (-12%)	88 (-13%)
	Elongation (%)	310 (-21%)	340 (-13%)	371 (-20%)
80 °C × 14 days	Hardness (JIS - A)	68 (+7 points)	67 (+6 points)	66 (+8 points)
	Tensile strength (kgf/cm <sup>2</sup> )	90 (-22%)	94 (-16%)	80 (-21%)
	Elongation (%)	310 (-21%)	360 (-8%)	360 (-23%)

Table 6: Pressure cooker test

	Properties	Plain sample (Comparative Example 1)	Antibacterial silicone rubber (Example 1)	Antibacterial silicone rubber (Comparative Example 2)
3 days	Hardness (JIS - A)	68 (+8 points)	68 (+7 points)	66 (+8 points)
	Tensile strength (kgf/cm <sup>2</sup> )	97 (-16%)	94 (-16%)	91 (-10%)
	Elongation (%)	339 (-13%)	363 (-7%)	351 (-25%)
7 days	Hardness (JIS - A)	70 (+10 points)	69 (+8 points)	67 (+9 points)
	Tensile strength (kgf/cm <sup>2</sup> )	93 (-19%)	83 (-28%)	85 (-16%)
	Elongation (%)	323 (-17%)	332 (-15%)	331 (-29%)
14 days	Hardness (JIS - A)	68 (+8 points)	70 (+9 points)	68 (+10 points)
	Tensile strength (kgf/cm <sup>2</sup> )	77 (-33%)	72 (-37%)	70 (-31%)
	Elongation (%)	261 (-33%)	285 (-27%)	232 (-50%)

There has been described a silicone rubber composition which yields a highly antibacterial and antifungal silicone rubber possessing good physical properties.

Japanese Patent Application No. 5-235798 is incorporated herein by reference.

5 Although some preferred embodiments have been described, many modifications and variations may be made thereto in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

#### Claims

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1. A silicone rubber composition comprising  
(i) curable organopolysiloxane, and  
(ii) zeolite containing 0.1 to 15% by weight of silver ion.

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2. A composition of claim 1 which contains 100 parts by weight of the organopolysiloxane and about 0.05 to about 50 parts by weight of the zeolite.

3. A composition of claim 1 or claim 2 wherein said zeolite further contains copper or zinc ions.

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4. A composition of any of the preceding claims wherein said zeolite further contains ammonium ions.

5. A cured silicone rubber comprising an amount, effective to give antibacterial and/or antifungal action, of zeolite containing from 0.1 to 15wt% exchanged silver ions.

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6. Use of zeolite, containing from 0.1 to 15wt% exchanged silver ion, as an antibacterial and/or antifungal additive for silicone.

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